Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221

ENTERED

20 MAY 2003

Mr. Frank Marcinowski, Director
Office of Radiation and Indoor Air
U.S. Environmental Protection Agency
401 M. Street, S. W.
Washington, DC 20460

Dear Mr. Marcinowski:

Thank you for your letter dated March 11, 2003 discussing our proposed changes to the Majorana project. We also had the opportunity to further discuss this and other potential underground physics projects with several members of your staff when they were in Carlsbad the week of April 21, 2003. Enclosure 1 provides a supplemental discussion of several aspects of the project and the additional information that you requested in your letter. Enclosure 2 is a set of graphics that depict the configuration for the proposed experiment. Enclosure 3 provides a revised EPA checklist that addresses all counting stations in this experiment. Finally, Enclosure 4 is a revised liquid nitrogen hazard analysis.

The Majorana experiment that was approved by the EPA did not progress beyond the design stage and was never installed or operated at the WIPP. At this time, the Carlsbad Field Office (CBFO) is seeking EPA approval to proceed with an updated configuration of the experiment. The attached information provides further clarification and additional information regarding the experiment.

The CBFO believes that these changes are minor and fall within the framework of the original Majorana approval.

- All the detectors are based on the same solid state principles.
- The nature and purpose of each counting station is related to solving engineering issues that are related to the overall Majorana program. Each is doing research and development that will contribute to a more sensitive and accurate Majorana double beta decay project for the future.
- Each of the detectors, or detector arrays, is cooled with liquid nitrogen, detect neutrino events using the same technology, and block background events using a similar passive lead brick shielding structure.

Installation of the double beta decay experiment in the existing Room Q Alcove will require no new excavation and all materials and equipment will be removed from the WIPP underground at the end of the experiment. Therefore, CBFO believes that the

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revised experiment will not create any change to the long-term performance of the repository. Neither will it affect our ability to collect effluent samples to demonstrate continued compliance with 40 CFR 191, Subpart A.

If you have additional questions, pleased contact Mr. Roger Nelson at (505) 234-7213.

Sincerely,

Chuan-Fu Wu for
Dr. Inés R. Triay
Manager

MAY 2003

Enclosures

cc: w/enclosures
L. Smith, EM-23
B. Forinash, EPA-ORIA
C. Byrum, EPA-ORIA
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Enclosure 1

Additional Information Requested by the EPA in Support of Proposed Changes to the Majorana Project

Additional Information Requested by the EPA in Support of Proposed Changes to the Majorana Project

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Background

To avoid potential confusion several terms need to be clarified. A detector is one wafer or crystal. A counting station can be one detector or multiple detectors working as one sensing unit. A counting station with multiple detectors is also termed a detector array. The terms SEGA and MEGA, defined below, are used in this document to refer to a collection of counting stations that are supporting the same research goals for the same experiment originally called the Majorana experiment. The collaborators now refer to this same experiment as the Segmented Enriched Germanium Assembly (SEGA) and the Multiple Element Germanium Array (MEGA) Experiment. Additionally SEGA, as well as MEGA, are counting stations and the SEGA design may be incorporated into the MEGA design if the research and development indicate that this is the best approach for a detector array. Figures provided in Enclosure 2 show the configuration of the experiment.

Although the Environmental Protection Agency (EPA) approved the Majorana experiment, it was never installed or operated in the WIPP underground for several reasons. The collaboration changed principal investigators. The responsibilities, the expectations for the experiment and the configuration of the experiment have evolved with the change in leadership and membership of the Majorana collaboration. Additionally, the collaboration met with the funding agency, DOE Office of Science, who requested some nomenclature changes. They did not like the use of Phase 1, Phase 2 and Phase 3 because they have specific uses for that wording and wanted to avoid confusion and because the agency wishes to fund smaller experiments with defined incremental goals rather than a large continuing program with phased, long-range less certain results. The previously titled Majorana Phase 1 activity is now called the Segmented Enriched Germanium Assembly (SEGA). Likewise, the Majorana Phase 2 activity is now called the Multiple Element Germanium Array (MEGA). Finally, the Majorana Phase 3 activity is now referred to as the Majorana project. The Majorana program still exists as an overall concept with SEGA and MEGA being distinct steps in the initial development. In addition to these changes, as time has elapsed, improved detectors have been developed and are ready to operate underground.

The technology goals of the Phase 1 Majorana, now termed SEGA, experiment were related to pulse shape analysis and segmentation, factors that affect the sensitivity of the eventual Majorana project detector. In December 2001, the time of the first Majorana submittal, the only detector that was built and operating at Duke University was the Triangle Universities Nuclear Laboratory - Institute for Theoretical and Experimental Physics (TUNL-ITEP) apparatus. This design and the planned SEGA detector were the basis for the description of the Phase 1 Majorana experiment submitted to the EPA. Since that time, the SEGA detector has been built and operated at Duke University and can be used at WIPP in Phase 1. The purpose of the new SEGA detector, like the TUNL-ITEP apparatus, is to evaluate detector sensitivity and identify the best detector geometry; hence, it is classified as a Phase 1 experiment. In addition, a third detector configuration has been developed since the original proposal. Los Alamos National Laboratory has proposed an experiment whose purpose is to identify the best shielding arrangement, to study and improve detector electronics and to improve the data acquisition algorithm performance. The nature of this experiment makes it a part of the Phase 1 Majorana experiment. These changes will bring the total number of counting stations for Phase 1 (SEGA) to three.

There are two technology goals of the Phase 2 Majorana experiment, which is now named MEGA. First, the technology to cool the apparatus will be studied. Second, research and development will be conducted concerning how to improve the design of the electronics to make the array work efficiently. In December 2001, the time of the first Majorana submittal, the Phase 2 design consisted of a doughnut-shaped cryostat holding 12 to 16 germanium crystals. Each crystal is a detector, and the total collection of crystals comprises a counting station. The current plan for the MEGA design is a doughnut-shaped cryostat holding 16 to 18 germanium crystals. Sixteen of these detectors will be in an annular cryostat (the doughnut) surrounding 0, 1, or 2 individual inner crystals (the hole of the doughnut) under special test. The purpose of the test will be to design the best cooling configuration for the array and design the best connection configuration for the array.

The November 2002 submission to the EPA proposed, in addition, an underground counting facility. The reason for adding this proposed facility to the last submittal was that one of the participating SEGA and MEGA collaborators, as a member of the National Nuclear Security Administration, had identified limited left over fiscal year 2002 funds. These left over funds could have been applied to a counting facility in the WIPP underground to help with national and homeland security issues. The opportunity to apply these funds to the WIPP has passed. The collaboration is reassessing what such a counting facility would look like and wishes to remove this facility from the SEGA and MEGA experiment submittal to the EPA. At the time the design and application is formalized it will be submitted to the EPA as a new proposal. Using MEGA as a low-background counting facility for screening materials or for national security purposes will cover this need in the short term and provide an additional role for MEGA.

The above developments made it more effective to add counting stations to the experiment. This collection of counting stations destined for the WIPP Room Q Alcove all share similar goals, infrastructure and functionality (e.g. double beta decay studies). The safety aspects, the hazards and the infrastructure requirements have not changed from the original proposal and the counting stations are within the safety envelope of the first evaluation. Enclosure 3 is an updated documentation checklist that reflects the additional elements of this experiment.

Carlsbad Field Office (CBFO) of the Department of Energy (DOE) believes that these evolutions are minor in nature. All of the counting stations under the umbrella of this experiment have the following similarities:

- All the detectors are based on the same solid-state principles.
- The nature and purpose of each counting station is related to solving engineering issues that are related to the Majorana program.
- Each is doing research and development that will contribute to a more sensitive and accurate Majorana double beta decay project for the future.
- Each of the detectors or detector arrays is cooled with liquid nitrogen, detect neutrino events using the same technology, and block background events using a similar passive lead brick shielding structure.

The same infrastructure, to be provided by WIPP, is needed for the SEGA and MEGA experiments as for the original Majorana experiment, namely liquid nitrogen, electricity, telecommunications and Room Q real estate. The rates of consumption of liquid nitrogen and electricity are higher and the additional detectors will require an additional modular building to house the equipment. However, the hazards associated with each experiment are identical and the operational time in the WIPP underground is identical. The science goals of each experiment are identical (double beta decay) and the nature of the supporting equipment in each case is identical. Enclosure 4 is a revised liquid nitrogen hazard calculation. Table 1 of the original Majorana Project Description submitted to the EPA in December 2001 identified the research and development goals of each Phase of the Majorana program. The technology and science goals of Phase 1 are now the goals of SEGA and the technology and science goals of the Phase 2 are the goals of MEGA. For these reasons the CBFO believes that the changes do not represent significant departures from the approved Majorana proposal.

Description

SEGA Apparatus

This experimental apparatus consists of a single germanium detector inside a lead shield. The device is internally segmented into 12 parts that can be read independently. The purpose of this experiment is to establish the best geometry for the detector and to configure optimal shielding. The configuration of SEGA will be a high purity germanium detector encased in a modest lead shield with a thin copper inner liner. The high purity germanium detectors operate at liquid nitrogen temperature by cryostat contact with a 30-liter liquid nitrogen Dewar. SEGA will consume about 0.14 liters of liquid nitrogen per hour of operation. The lead brick enclosure will be manually built from approximately 850 ~25-pound lead bricks (8-inch by 4-inch by 2-inch). The exterior dimensions of the lead enclosure are 32-inch width, 32-inch length and 40-inch height. The dimensions of the interior of this enclosure will be approximately 8-inch width, 8-inch length and 14-inch height. Outside the lead shielding there may be a thin (less than 0.25 inch) cadmium jacket constructed using sheets between 12 inches and 18 inches in width with waterproof duct tape to provide a seal between the sheets. This absorbs thermal neutrons and does double duty in providing a positive barrier to radon daughter intrusion. Outside this layer will be heavy plastic sheeting simply to prevent human exposure to the cadmium. Use of the cadmium shielding will be decided during an early test of the detector. Finally, a layer of neutron moderator (plastic, paraffin, or containers of water) may be temporarily placed as an outer shield to determine the effects of neutrons on the system. The liquid nitrogen Dewar will be located external to the lead enclosure within the large connex unit and have a height of 24 inches and a diameter of 17.38 inches. This is to validate the proper geometry and shielding for the experiment, one of the necessary, cutting principles of the design. Operation of the SEGA detector is expected to last about one to three years.

MEGA Apparatus

This experimental apparatus will consist of a toroidal (doughnut-shaped) cryostat holding several (16-18) germanium crystals. Sixteen of these will be in an annular cryostat surrounding 0, 1, or 2 individual detectors, which will occupy the inner space of the annulus. This unusual detector system is designed to surround the one or two germanium detectors under special test. The detector design from SEGA may be incorporated as one of the two inner detectors within the central hole in the toroidal detector. The number of inner detectors will be determined during the experiment. The lead shield for MEGA will be constructed from a larger number of lead bricks. The same external shielding jacket configuration from SEGA will be employed with a suitable geometry to enclose the cryostat and detector system. The configuration of this counting station is more complex because of the necessity of having several liquid nitrogen Dewars to cool the many Germanium crystals in the system. The complex detector array will boil off between 0.4 liters per hour and 7 liters per hour of liquid nitrogen. To determine the exact rate of liquid nitrogen consumption is one purpose of the research being conducted. Another purpose of this configuration is to provide material assay and counting of double-beta decay isotopes. If a low-background counting facility for screening materials is needed to support national security efforts, MEGA can provide that role for the U. S. Government. After appropriate development and testing, MEGA will run for a period of four to five years.

TUNL-ITEP Apparatus

The current TUNL-ITEP double-beta decay apparatus consists of two high-purity germanium detectors, a disc-like sample of the isotope under study, and an active and passive veto system. Each of the two high purity germanium detectors is 8.8 cm in diameter and 5.0 cm long. They are enclosed in cylindrical housings made of aluminum that are attached via cold fingers to two 30 liter liquid nitrogen Dewars. The 1 kg sample (provided by ITEP; therefore the name TUNL-ITEP apparatus) is located between the two high purity germanium detectors. This sample is an isotope sensitive to double beta decay such as isotope Mo-100. These components are surrounded by a 4-inch thick sodium iodide annulus that is equipped on both ends with 8 photomultiplier tubes. The outer diameter of the annulus is about 26 inch and its total length (including the photomultiplier tubes) is about 36 inches. Two plastic scintillator plates each equipped with two photomultiplier tubes cover the open ends of the sodium iodide annulus. The main purpose of the annulus and the plastic scintillator plates is to reject (or veto out) events from background radiation reaching the high purity germanium detectors from the outside. This is a veto shield. The experiment is interested only in the events from the sample disc located between the two high purity germanium detectors; we expect about 20 events per year from the disc compared to billions of events coming from the outside. The entire apparatus is surrounded by an enclosure of lead bricks (of size 2 inch by 4 inch by 8 inch) with wall thickness of 12 inch on the four sides and 4 inches on the top. A steel plate of 1-cm thickness supports the lead roof. The lead enclosure forms the passive veto system. The outer dimensions of the entire apparatus are 60 inch in length, 40 inch in width and 32 inch in height. The lead enclosure is surrounded by an additional 4-inch thick plastic enclosure to reduce the neutron background in the high purity germanium detectors. The purpose of the experiment is to search for the double beta-decay to excited states in specific isotopes. The isotope samples are modestly sized (about 15.9 cubic inches) samples of enriched material. Examples of the enriched materials are isotopes of such elements as Se, Mo, Nd, Cd, and Zr. These isotopes have a high cross section for double beta decay events. At TUNL the isotope Mo-100 was studied successfully. The TUNL-ITEP apparatus consumes 0.32 liters of liquid nitrogen per hour when operating. TUNL plans to repeat this experiment for about six months at WIPP to experiment with different conditions. For example, tests will be made with and without the sodium iodide annulus and the plastic scintillators. The expectation is to eliminate this extra shielding due to the greatly reduced cosmic-ray background in the underground at WIPP. After the collaboration determines the necessary shielding, they plan to measure the double-beta decay to excited states of Nd-150. On surface, as operated today, the TUNL apparatus is not sensitive enough to observe the extremely rare double-beta decay events (expected less than 5 events per year) for this isotope. The double-beta decay experiments to excited states of the daughter nucleus are the first step toward the much larger and much more important neutrino-less double beta-decay search on Ge-76, i.e., the full Majorana Project. The installation and test of the TUNL apparatus at WIPP and the associated Nd-150 measurement are the thesis project of C.L. Hoe.

LANL Apparatus

This device will include two germanium detector arrangements. These will be un-enriched detectors that compose a different configuration of detector crystals than MEGA and a different segmentation than SEGA. The external shielding will be lead bricks surrounded by sheets of boron loaded plastic. Like the SEGA shield, the lead brick enclosure will be manually built from approximately 850 ~25-pound lead bricks (8-inch by 4-inch by 2-inch). The exterior dimensions of the lead enclosure will be similar to the SEGA enclosure. The dimensions of the interior of this enclosure will again be similar to the SEGA counting station. As stated above, one purpose of the Los Alamos National Laboratory (LANL) experiment is to identify the best shielding arrangement to improve detector sensitivity. The design will test the usage of a cadmium jacket as described in the SEGA shield. The cadmium may not be a part of the final design. The jacket would be a thin (less than 0.25 inch) cadmium jacket constructed using sheets between 12 inches and 18 inches in width with waterproof duct tape to provide a seal between the sheets. The LANL apparatus will boil-off about ten liters of liquid nitrogen per day during a continuous operation of 24/7 run. This amounts to about 0.42 liters per hour. These detectors will be used to further verify the background rejection techniques of segmentation and close packing. In addition, they will be used for material screening. Raw materials that will be used for the construction of the future Majorana experiment such as plastics or metals, or even electronic components like resistors will be counted. In addition one might count finished assemblies such as an electronic circuit. The detectors will also be used for research and development of the calibration techniques for the full Majorana assembly. Finally, the experiment will investigate methods to reduce background noise from cosmic muons. Electronic settings will be adjusted and data acquisition software will be modified to improve the signal to noise ratio for the counting station. Improved noise rejection capabilities will allow more astrophysics experiments to be conducted at the relatively shallow depth of the WIPP.

Infrastructure

As a general note that applies to all counting stations, the detector calibration for each station will use a Coleman® lantern mantle and probably a sealed Co-60 source (<10 micro-curies). The total boil off usage of liquid nitrogen will be limited to less than 20 liters per day for the complete set of counting stations. SEGA is presently being tested above ground at TUNL along with the TUNL-ITEP apparatus. While the installation of the detectors will be conducted over a six-month period (June 2003 to December 2003), the plan is that SEGA, the TUNL apparatus, and the MEGA will operate at the same time at WIPP to be able to compare results. The SEGA and TUNL installations will precede the MEGA installation. After an estimated five years of operation the experiment will conclude and all equipment will be decommissioned and removed from the WIPP Underground. Finally, the SEGA and MEGA experiment is subject to all conditions identified in the original Majorana Project Description. Operations on the experiment that require the support of WIPP Underground Operations shall be scheduled at a lower priority to not interfere with waste disposal operations. All equipment and materials used for the experiment will be physically separated from all waste disposal activities and no components from the experiment will be stored (temporary or long-term) in the waste disposal path. All equipment and materials related to the experiment shall be removed upon completion of the experiment.

Response to EPA Questions

A response to questions and the additional information that the EPA requested is presented below for each element of the SEGA and MEGA experiment.

The EPA states "Based on our review, it appears that SEGA is analogous to Phase 1 and MEGA is approximately the same as the Phase 2 originally approved. However, note that EPA's original approval allowed the use of only two detectors, one for each Phase. DOE's statement regarding "three stations in the original Majorana configuration" suggests that the existing Majorana experiment may have been modified without EPA approval."

The EPA evaluation is correct that SEGA is analogous to Phase 1 and MEGA is approximately the same as the Phase 2 originally approved. However, SEGA is a new detector being added by this request. The original approval contained only two counting stations, which were the TUNL-ITEP apparatus and the MEGA apparatus of an earlier design. However, if you refer to the Table 1 provided in the original Majorana project description, the technology and science goals of the Majorana experiment are identified. Using these definitions, DOE believes that the additional counting stations added conform to the original approval. The statement regarding three stations in the original Majorana configuration was an error; there were only two stations. The original experiment has been modified and the CBFO is seeking EPA approval for the new configuration without ever installing or operating the original approved Majorana experiment.

"Based on the limited information provided in the letter, the Triangle Universities Nuclear Laboratory apparatus appears to be a new type of detector not accounted for in the initial approval."

The Triangle Universities Nuclear Laboratory apparatus was the only unit built at the time of writing of the original Majorana Project Description. The original Majorana Project Description did not go into sufficient detail to acknowledge that the apparatus had two detectors. The term detectors used in that project description for Phase 1 equates a detector with a counting station.

"Finally, it is not clear whether the two sampling stations that will provide Los Alamos National Laboratory (LANL) an additional germanium detector arrangement to investigate background rejection techniques from cosmic muons are also new and beyond our previous Majorana Experiment Phase 1 and 2 approval."

The LANL apparatus is an additional new counting station, which contains two germanium detectors. This new station falls within the scope of the research and development undertaken by the Phase 1 science goals (see Table 1 below).

Counting Station	Detector Type & Number of Detectors*	Purpose	Relationship to Phase 1 or Phase 2 of Majorana Approval	Conforms to Existing Approval
SEGA	Ge ,1 detector	Study Geometry and Shielding	New Counting Station but Same as Original Phase 1 Experiment	Conforms to Phase 1 Technology Goal
MEGA	Ge, 18 (max) detectors	Evaluate cooling & array operation of detectors	Same as Original Phase 2 Experiment	Conforms to Phase 2 Technology Goal
TUNL-ITEP	Ge 2 detectors	Study Double Beta Decay Detection Media	Same as Original Phase 1 Experiment	Conforms to Phase 1 Technology and Science Goal
LANL	Ge, 2 detectors	Study Background Rejection Techniques	New Counting Station but Same as Original Phase 1 Experiment	Conforms to Phase 1 Technology Goal

*One detector in this column consists of one germanium crystal and associated electronics

Table 1 Comparison of SEGA and MEGA Counting Stations

Enclosure 2

Graphics Depicting the SEGA and MEGA Experiment in the Room Q Alcove

Graphics Depicting the SEGA and MEGA Experiment in the Room Q Alcove

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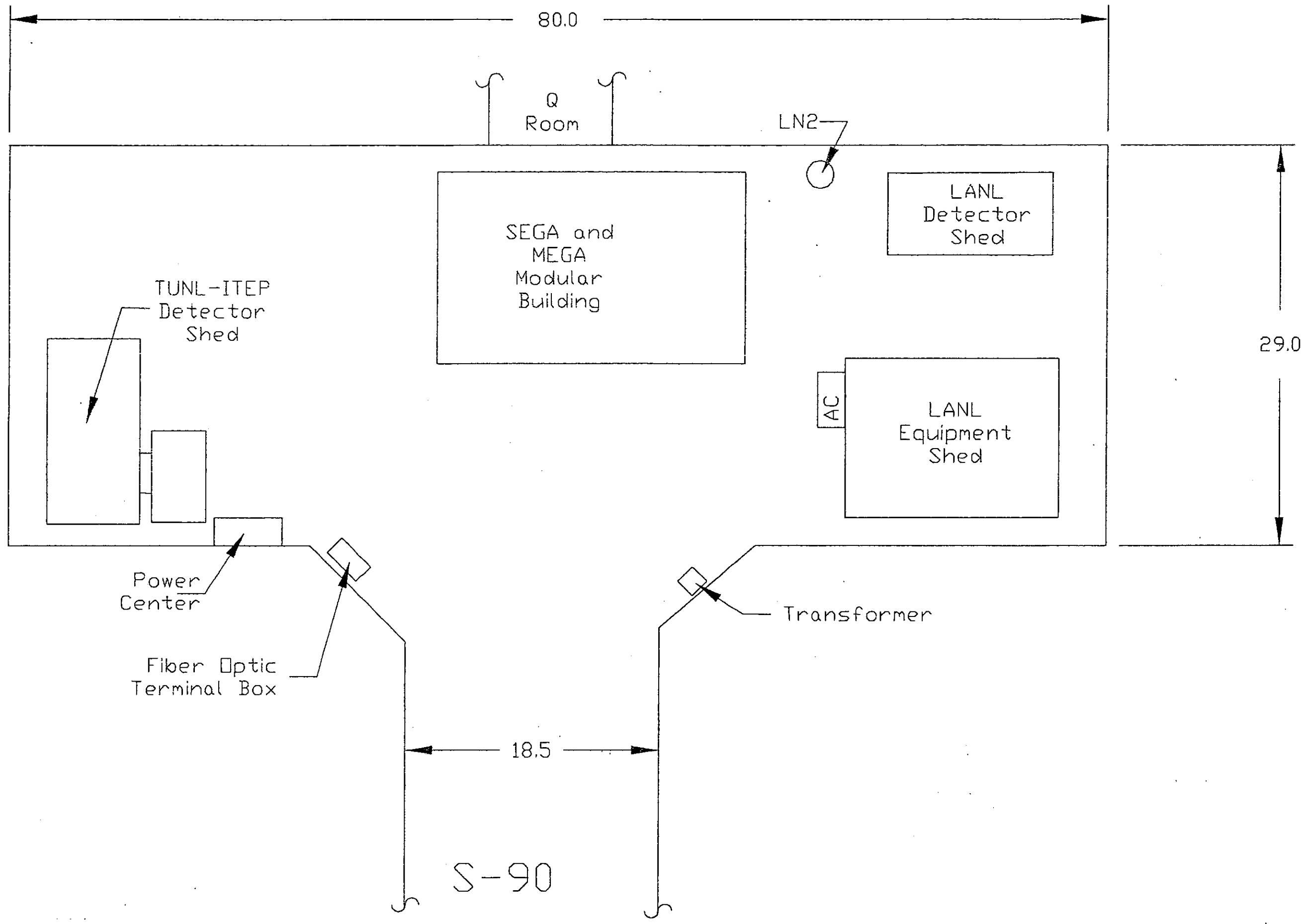

Figure 1 Layout of Room Q Alcove for SEGA and MEGA Experiment

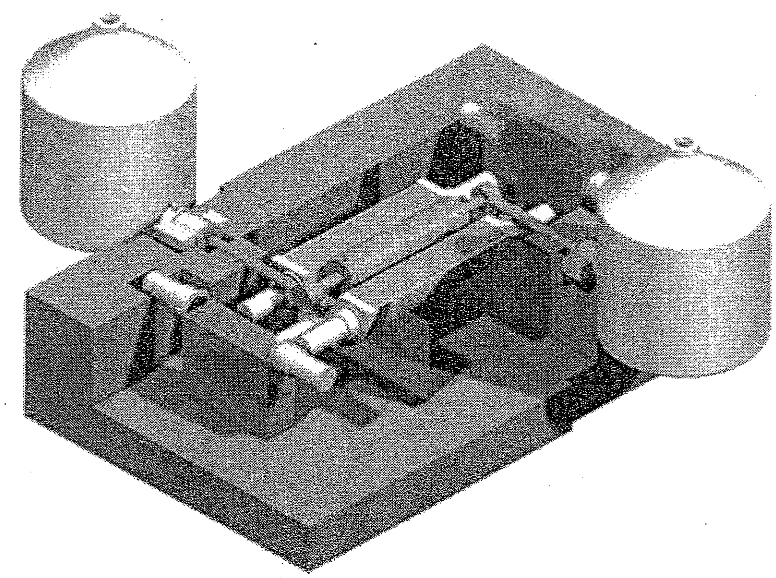

Figure 2: Cut-away view of the TUNL-ITEP apparatus.

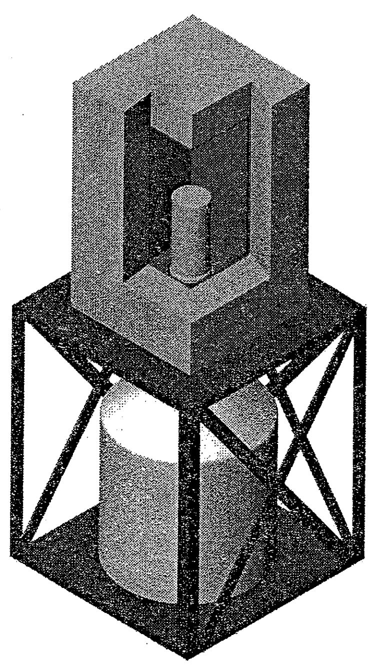

Figure 3: Cut-away view of the SEGA apparatus.

Note: the LANL Apparatus will be of a similar configuration.

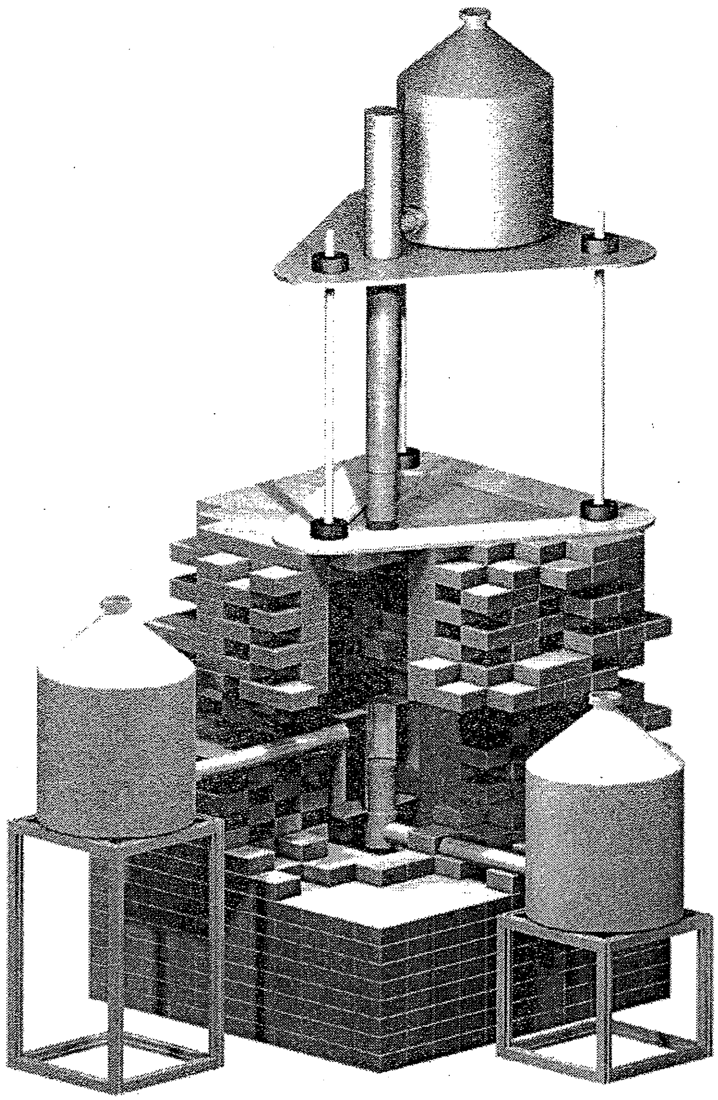

Figure 4 Depiction of MEGA apparatus.

Enclosure 3

Revised EPA WIPP Experimental Checklist

Revised EPA WIPP Experimental Checklist

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SEGA and MEGA Experiment
EPA WIPP Experiment Review Checklist

Primary interests and concerns related to placing individual experiments in the WIPP underground:

1. *Can the introduction of this experiment affect in any way the long-term integrity and viability of the WIPP as a disposal system for radioactive waste?*

   The potential for long-term impacts was considered during the project review process. Long-term impacts from this project are not anticipated because of the following:

   - the experiment will be conducted for 4 to 5 years, then be decommissioned,
   - the experiment will not change the repository footprint,
   - the experiment will not interfere with waste handling or emplacement,
   - the experiment utilizes materials with no potential for salt interactions, and all equipment, materials, and wastes will be removed from the site prior to decommissioning of the WIPP.

2. *Is there anything about the experiment that could alter the repository's design baseline from the terms of EPA's certification?*

   The design baseline of the repository will not be altered from the terms of EPA's certification by conducting the SEGA and MEGA astrophysics experiment at WIPP. As discussed in the above, the experiment will be located in the Room Q Alcove away from the waste disposal process and activities will be scheduled at a low priority so that the program cannot interfere with waste disposal operations nor adversely impact the long-term performance of the repository.

3. *Could this experiment's interaction with other experiments create potential hazards during the short-term operational phase or the long-term performance of the disposal system? In other words, are there any potential synergistic effects that could result from an accident that affects multiple, unrelated experiments or operations?*

   Due to the location, configuration, construction, and scope of the experiment there will be no potential synergistic effects to waste handling, other experiments, or to the long-term performance of the disposal system. The TUNL-ITEP apparatus, the LANL apparatus, the SEGA detector, and the MEGA array all operate independently from each other. The only common infrastructure shared is the source of liquid nitrogen. An updated liquid nitrogen hazard calculation has been performed to demonstrate that the collective set of counting stations in the Room Q Alcove cannot cause an oxygen deficiency relative to alcove ventilation.

Majorana Project Summary

Plan and Description

Enclosure 1 provides a comprehensive description of the configuration of each counting station included in the SEGA and MEGA experiment, including location, arrangement graphics, hazard analysis and required mitigation measures, estimated duration, potential impact on waste disposal operations, and potential to impact long-term repository conditions.

The SEGA and MEGA experiment will consist of a series of passive experiments to develop hardware to measure double beta decay events where the interactions are captured by the detector or detector array, converted to electronic signals, and routed into a computer data acquisition system. The sources that can cause these interactions include natural background radiation, cosmic rays, or a calibrated Co-60 source (<10 micro-curies), depending on the particular study being performed. Typical tasks that will be performed by the personnel operating the SEGA and MEGA experiment consist of the following:

- Perform standard, daily, underground operation inspections (ground control, ventilation, electrical power, mine communications, etc.)
- Inspect experiment for evidence of leaks, spills, or off normal conditions.
- Perform electrical system checks of equipment.
- Collect data from study.
- Revise the layout of the experiment to measure a new parameter and repeat the above tasks.

The Carlsbad Field Office (CBFO) Chief Scientist and the Managing and Operating Contractor Safety and Health (S&H) section will review and approve a test plan prior to the initiation of the experiment. As the experiment progresses, analysis of the results may be used to improve the design or alter specific portions of the test plan. Any time that the experiment is reconfigured, the appropriate industrial hygiene and safety procedures and controls will be utilized. These changes will be reviewed by the CBFO Chief Scientist and the S & H section and approved prior to their implementation. Wastes generated during reconfiguration will be characterized and disposed of in accordance with applicable regulations and WIPP procedures.

Location

The experiment will be located in the Q Room Alcove (QRA), W850 and S90 of the WIPP underground, and *utilize an area approximately 30 feet wide by 70 feet long* in the QRA. This location was chosen for the experiment because in this location it will not impact or interfere with waste disposal operations. The S90 drift is physically isolated from the waste handling traffic pattern and the waste disposal areas of WIPP. In addition, the drift is within a separate air ventilation circuit from the circuits used to service underground disposal operations.

Configuration and Organization

The SEGA and MEGA experiment is a passive cryogenic experiment designed to develop a precise double-beta decay detector. The primary components of the experiment will be up to three steel modular buildings containing the lead shielded detector array and the electronic equipment. The buildings will be air-conditioned and equipped with a high efficiency particulate air (HEPA) filter system. The detector array will consist of a cryostat containing one or more germanium detector crystals immersed in liquid nitrogen and surrounded by lead brick shielding. The cooling fluid for the cryostat is provided by a series of 30-liter liquid nitrogen Dewars.

The potential for synergistic impacts from this experiment was examined during the review process and no potential impacts were identified. Due to the location and scope of the experiment there will be no synergistic effects to waste handling or other experiments. *This experiment has no expected emissions or effluents that could impact existing experiments or waste disposal.* The amount of liquid nitrogen consumed during normal operation is negligible to the ventilation system. The experiment is completely separated from the disposal areas of the mine, and from the ventilation circuits that service those areas. In the event that a minor spill was to occur in the QRA, there would be no impact to existing underground experiments or waste handling/disposal operations. In the unlikely event of a significant spill or fire, regardless of the location, all underground activities will be placed in a safe condition and personnel will be evacuated from the underground.

The Environmental Assessment (EA) for Conducting Astrophysics and Other Basic Science Experiments at the WIPP Site completed a bounding impact assessment of a series of proposed experiments at the WIPP. The EA committed to determining if additional NEPA documentation would be required to assess potential environmental impacts for future experiments, as details of those experiments became available. In keeping with this commitment, a NEPA compliance checklist, developed in accordance with the WIPP NEPA Compliance Procedure, will be used to initiate regulatory review and address the cumulative impacts of future experimental programs, including the SEGA and MEGA experiment.

Hazard Analysis

The planning, siting, and safety review processes required for conducting the SEGA and MEGA experiment in the WIPP underground included a comprehensive assessment of the experiment's potential impact and hazards. The short operational duration, passive nature, and isolated location of the experiment preclude any short-term or long-term impact to waste emplacement operations in the repository. Because the experiment does not change the footprint of the repository, has no expected effluents other than nitrogen gas, requires no special utilities or unusual infrastructure requirements, and will be completely removed from the underground prior to repository closure, it has no short term or long term impact on the repository design, operation, or long-term performance.

An Unreviewed Safety Question (USQ) screening was completed for the original Majorana experiment and the SEGA and MEGA revisions were compared to the original USQ. Because the hazards and infrastructure is identical to the original experiment, the determination if the impacts of conducting the experiment at WIPP would impact of the safety basis described in the WIPP Safety Analysis Report (SAR) does not change. The USQ process evaluated whether events associated with the experiment could result in an unplanned release of radioactive material, result in a new type of initiating event not previously identified, or be considered a new type of accident not bound by previous accidents evaluated in the SAR. An initiating event would be some event from the experiment that would cause a credible, new, radiological accident not previously considered by the SAR. This evaluation determined that potential accidents associated with the experiment can not effect the WIPP safety basis defined in the SAR and would not impact CH TRU waste disposal certification.

A Job Hazard Analysis (JHA) was performed during the original Majorana review process to evaluate potential industrial safety accident scenarios, assist in the development of safety and industrial hygiene programs to control or mitigate potential personnel exposures, and address response to potential incidents. This JHA still applies to the SEGA and MEGA experiment because the infrastructure requirements and the hazards associated with SEGA and MEGA are identical. The JHA identifies hazards associated with the lead shielding, cadmium, liquid nitrogen, and electrical power supply. In general, the identified hazards were:

- the intrinsic weight of the lead bricks and potential for airborne lead dust,
- the potential for frostbite burns from contact with cryogenic surfaces or spillage of liquid nitrogen,
- the potential for asphyxiation from oxygen displacement by nitrogen gas, and
- the possibility of fire due to the presence of combustible wood pallets and electrical power.

The JHA evaluated industrial safety and health hazards associated with the experiment to provide a response to proposed incidents and identify actions to control or mitigate potential personnel exposures. The JHA demonstrates that the WIPP facilities and infrastructure can provide support for this project without interfering with the primary mission of WIPP, to safely manage and dispose of transuranic wastes. The safety protocols and controls required to prevent injury or accidents and mitigate potential exposures from these hazards are described in detail in the JHA.

The experiment area will be supplied with approximately *18,000 cubic feet* of air per minute from the air intake shaft using an exhausting system. Fresh air will be drawn from the air intake shaft westward through S90, circulated through the alcove and then enter an auxiliary ventilation duct that extends along the S90 drift. The auxiliary ventilation duct will transport the circulated air eastward past the air intake shaft and discharge into the W170 drift. The W170 drift carries exhaust air from the active mining area and flows directly to the exhaust shaft without passing through any additional work areas. See Figure 1 below.

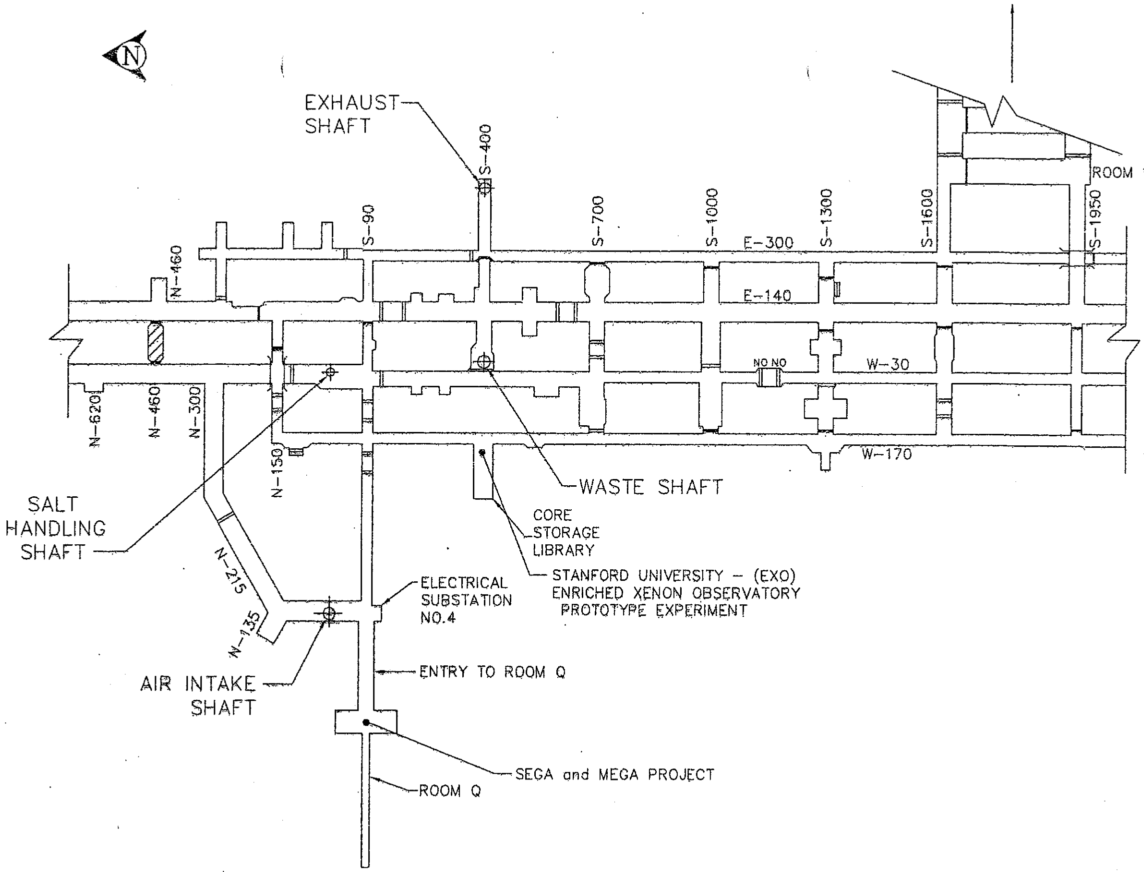

Figure 1 Location of SEGA and MEGA Project

Experimental equipment and personal will be transported underground so that their introduction will not interfere with waste disposal operations. Construction and experiment operational activities, including the movement of materials, will be coordinated with the Washington TRU Solutions CH Waste Operations and Mine Operations Sections to ensure that equipment and personnel are available to support required tasks. Materials will be moved during the back shifts, as necessary, to avoid potential conflicts with TRU waste operations.

Both the USQ and JHA specifically addressed potential accident and failure scenarios. The USQ screening process evaluated the experiment to determine possible impact to the WIPP safety basis and determined that the experiment will not impact the safety basis of the CH waste process.

The potential for long-term impacts was considered during the project review process. Long-term impacts from this project are not anticipated because of the following:

- the experiment will be conducted for 4 to 5 years and then be decommissioned,
- the experiment will not change the repository footprint,
- the experiment will not interfere with waste handling or emplacement,
- the experiment utilizes materials with no potential for salt interactions,
- the location of the experiment will be actively managed for ground control,
- and all equipment, materials, and wastes collected at WIPP before, during and after the operation of the experiment will be managed according to approved WIPP procedures,
- and all equipment, materials, and wastes will be removed from the site prior to decommissioning of the WIPP.

Installation of equipment used in the experiment will be conducted in accordance with standard WIPP work authorization processes to ensure engineered safety features and controls are implemented to prevent the occurrence of accidents. These processes require Engineering Change Proposals to be developed and standard environmental, safety, and regulatory compliance reviews of the proposals to be performed prior to implementation.

The hazards and safety protocols/controls identified in the JHA will not impact the approved certification design of the repository. The experiment will be built using inert materials, the lead bricks and cadmium jacket forming the detector shielding, the solid-state germanium detectors, and a cryostat system containing liquid nitrogen. These materials will be removed from the site prior to repository closure and have no short-term potential for salt interaction.

Installation and Implementation

Installation of equipment used in the experiment will be conducted in accordance with standard WIPP work authorization processes. These processes require Engineering Change Proposals to be developed and standard environmental, safety, and regulatory compliance reviews of the proposals to be performed prior to implementation.

Construction of the SEGAS and MEGA experiment is estimated to require about 90 hoist trips for downloading of materials and equipment. Experimental equipment and personal will be transported underground so as to not interfere with waste disposal operations. Construction and experiment operational activities, including the movement of materials, will be coordinated with the Washington TRU Solutions CH Waste Operations and Mine Operations Sections to ensure that equipment and personnel are available to support required tasks. Materials will be moved during the back shifts, if necessary, to avoid potential conflicts with TRU waste operations.

Similar to the original Majorana project, review of the construction requirements and the operating plans indicate that not more than 8 experimenters will be required to construct and operate the experiment on a daily basis. Additional collaborators may visit the project from time to time.

Completion and Removal

All equipment, materials, and wastes will be removed from the site prior to decommissioning of the WIPP as defined in the WIPP Hazardous Waste Facility Permit.

Enclosure 4

Revised Liquid Nitrogen Hazard Calculation

Revised Liquid Nitrogen Hazard Calculation

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Revised Liquid Nitrogen Release Calculations for the SEGA and MEGA Experiment

Determine the air exchange rate required to support the ventilation required to sustain a safe atmosphere in an 10' x 18' x 24' modular building in the underground assuming a consumption rate of 7.14 liters/hour in the modular building, and determine the effect of changing the usage rate from 60 liters/week to 20 liters/day.

The original analysis calculated the make-up air required to maintain oxygen levels at greater than 19.5 percent, during a hypothetical catastrophic release of liquid nitrogen from a 30 liter counting station support Dewar, and during routine use, assuming an evaporation rate of 30 liters/week/Dewar.

The calculation of a hypothetical catastrophic release from the main external supply Dewar does not change because the liquid nitrogen supply mechanism (a 250 liter Dewar is the same), and may be used as-is.

From the calculation performed for Majorana, for routine operations daily evaporation, it was calculated that 1.9 ft3/min dilution air is required to provide adequate dilution for evaporation of 60 liters/week (2 Dewars of liquid nitrogen).

Converting time to minutes and solving for volume of dilution air required for each liter of liquid nitrogen evaporated:

60 liters/week / 10080 minutes/week = .00595 liters/minute
1.9 ft3/min / .00595 liters/minute = 319 ft3 dilution air / liter of liquid nitrogen evaporated.

Assuming a total use rate of 7.14 liters/hour in the modular building for SEGA and MEGA:

7.14 liters/hour / 1440 minutes/day = 0.119 liters/minute
0.119 liters/minute x 319 ft3 air/liter N2 = 37.96 cfm dilution air required (make-up and exhaust).

Provision of this quantity of ventilation in the connex will not be a problem. Please note that there is an additional safety factor in that freshly evaporated N_2 is still quite cold and dense, and will tend to subside to floor level. Ventilation of the connex should be designed to exhaust from floor level.

Assuming a total use rate of 20 liters/day:

20 liters/day / 1440 minutes/day = .0139 liters/minute
.0139 liters/minute x 319 ft3 air/liter N_2 = 4.43 cfm dilution air required (make-up and exhaust).

Conclusion

- With 60 cfm minimum Room Q Alcove air flow, release of liquid nitrogen to the alcove is not a problem.
- 37.96 cfm of dilution air is required inside the SEGA and MEGA modular building.
- 4.43 cfm of dilution air is required inside the Room Q Alcove for all experiments.
- Ventilation of the modular building should be designed to exhaust from floor level.
- The original analysis during a hypothetical catastrophic release of liquid nitrogen is valid because the liquid nitrogen supply mechanism (a 250 liter Dewar is the same), and may be used as-is.